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AN EVALUATION OF ALTERNATIVE FUNCTIONAL MODELS OF NARRATIVE SCH--ETC(U)
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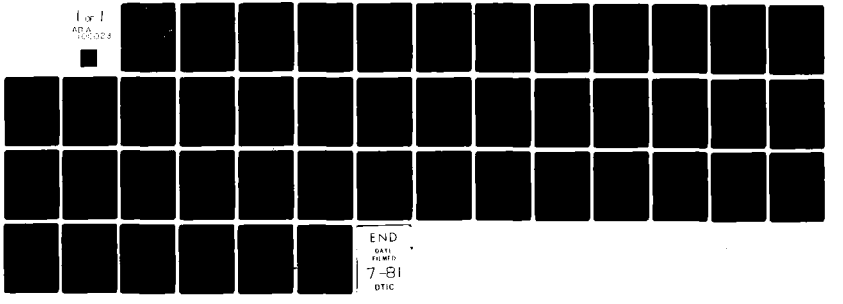

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AN EVALUATION OF ALTERNATIVE FUNCTIONAL MODELS OF NARRATIVE SCHEMATA

Frank R. Yekovich and Perry W. Thorndyke

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AN EVALUATION OF ALTERNATIVE FUNCTIONAL MODELS OF NARRATIVE SCHEMATA

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Recent research on human memory for text has focused on modeling both the underlying semantic structure of text and the memory structures that encode and interpret this information. Several investigators have proposed representational schemes that encode a text as a network of connected propositions (e.g., Kintsch, 1974; Frederiksen, 1975; Meyer, 1975). Typically, these schemes represent a passage's propositions in a semantic representation that is organized hierarchically (Kintsch, 1974; Meyer, 1975). The centrality of a proposition to the overall meaning of the passage determines the proposition's importance of "level" in the representational hierarchy. Propositions with many connections to other propositions and that subsume other ideas occupy upper levels of the organizational structure. Propositions with few connections and that elaborate other ideas are represented at lower levels. Several empirical studies have demonstrated that a person's memory for expository prose information is a function of propositional location within the text's hierarchical structure: important propositions are remembered better than unimportant ones (Kintsch, 1974; Kintsch, Kozminsky, Streby, McKoon & Keenan, 1975; Meyer, 1975; Meyer, Haring, Brandt & Walker, 1980). This recall phenomenon appears to be quite robust and has come to be called "the levels effect."

A related line of memory research has addressed the human knowledge structures that guide the encoding and parsing of simple narrative stores (Kintsch, 1977; Kintsch & van Dijk, 1975; Mandler, 1978; Mandler & Johnson, 1977; Rumelhart, 1975, 1977; Stein & Nezworski, 1978; Thorndyke, 1977, 1978). This work has modified Bartlett's (1932) notion of a memory schema to characterize the knowledge of narrative structure that people use during comprehension and retrieval of stories. Although

exact theoretical formulations of narrative schemata differ across researchers (see Johnson and Mandler, 1980, for a discussion of these differences) enough commonalities exist among the models to treat them collectively (see Thorndyke & Yekovich, 1980). In all of these models, memory schemata for narratives provide a representation of the common organization occurring in most stories. This organization is expressed as constraints on the arrangement of situations and events that constitute the plot of a well-formed passage. For example, in a typical brief story, a protagonist tries to achieve some goal. The plot sequence normally comprises statements regarding (a) the introduction of the main character and the problem to be solved, (b) one or more episodes aimed at solving the problem, and (c) an eventual resolution. These stereotypical descriptions constitute high-level expressions of the abstract structural elements common to narratives. Accordingly, the constraints on the structure of a simple story can be expressed by a grammar that details the story constituents and their rules of combination. A complete representation of a story using a structural grammar consists of a hierarchical tree of nodes and relations. The intermediate nodes of the tree encode the structural properties of the story, while the terminal nodes of the tree encode the propositions from the text that correspond to the low-level constituents.

In general, the number of nodes separating a terminal node from the top of the tree indicates the scope, generality, and hence importance of the proposition. Accordingly, important story propositions corresponding to high-level story constituents (e.g., theme, resolution) occur high in the organizational hierarchy, while detailed actions embedded in the plot assume positions low in the structure. As in the studies of

memory for expository prose discussed above, people's memory for narrative prose demonstrates the levels effect. Several studies have shown that people are more likely to remember propositions that occur high in the structural hierarchy than low in the hierarchy (Rumelhart, 1977; Thorndyke, 1977, 1978), although this result has recently been challenged (Black & Bower, 1980).

The narrative schema concept has been used widely in interpreting comprehension and retrieval of a variety of texts. However, as we have pointed out elsewhere (Thorndyke & Hayes-Roth, 1979; Thorndyke & Yekovich, 1980), most research on memory schemata has been restricted to particular types of hypothetical structures. In contrast, relatively little research has investigated the cognitive processes that control schema-based operations, or the critical evaluation of alternative structural models. Only very recently have researchers begun to investigate questions such as how memory schemata are acquired (Thorndyke & Hayes-Roth, 1979) or how they operate during text comprehension (Chiesi, Spilich & Voss, 1979; Cirilo & Foss, 1980; Kintsch & van Dijk, 1978; Spilich, Vesonder, Chiesi & Voss, 1979) and retrieval (Mandler, 1978). Specification of the memorial processes that control and use schemata is prerequisite to the development of a complete theory of human memory (Thorndyke & Yekovich, 1980).

This paper evaluates several alternative models for how narratives are encoded, represented, and retrieved from memory. In particular, we address four questions regarding the use of narrative schemata in memory. (1) do narrative schemata bias the likelihood of encoding text information? In other words, does the levels effect in recall reflect differences in the encoding of text propositions? (2) are

the representations for stories hierarchical (as suggested by story grammars) or heterarchical? Third, does retrieval and recall of propositions from memory depend on a top-down search of the hierarchical memory structure, or can propositions be directly accessed? Fourth, does the memory representation of a text retain the surface information of the text, or is this representation conceptual? These questions define four attributes (encoding bias, memory structure, search process, memory contents), each with two or more values. Different values for these attributes may be combined to form a variety of alternative models for text memory and recall. In the next section we discuss these attributes in more detail, and then delineate a number of plausible candidate models within the general "memory schema" framework. We then present an experiment to comparatively evaluate these models.

Model Attributes

Encoding Bias. All models positing memory schemata for stories assume that the comprehension and encoding of narratives is guided by these schemata. Such schemata permit expectation-driven comprehension and encoding according to the structural constraints of the schemata. The levels effect in story recall and summarization has been taken as evidence for the hierarchical encoding of stories (Rumelhart, 1975, 1977; Thorndyke, 1977, 1978). However, it is not clear precisely what produces this effect. One possible explanation is that narrative schemata differentially bias the encoding of incoming propositions. The amount of processing (attention, elaboration, integration) a proposition receives could be a function of its scope and generality, and hence its importance (Cirilo & Foss, 1980). For example, propositions more cen-

tral to the main theme may receive more attention either because of a greater degree of elaboration during encoding (Anderson & Reder, 1979. Reder, 1979) or because they require more integration with other propositions (Kintsch & van Dijk, 1978). Thus, the encoding of propositions would reflect the amount of initial processing. Differences in the encoding of propositions might derive either from differential probabilities of encoding or from differential qualities (elaboration, completeness, etc.) of the encoding. In either case, these storage differences among the narrative propositions would produce the observed levels effect in propositional recall.

An alternative explanation assumes that the levels effect reflects retrieval rather than storage processes. According to this view, all story propositions are encoded with equal probability, but are recalled differentially because the retrieval process favors certain propositions over others. For instance, assume that a hierarchical, narrative schema provides a retrieval plan for an ordered search of the stored information. A top-down, breadth-first search for propositions in the structure would reproduce the correct serial order of propositions. Assuming the search process is probabilistic (e.g., Collins & Loftus, 1975), successful retrieval of story propositions would be a function of the amount of search required--the more extensive the search, the lower the retrieval probability. Thus, propositional retrieval probability would decrease with the depth of the proposition in the representation hierarchy.

Traditionally, storage and retrieval effects have been distinguished by considering the (in)dependence of the recognition and recall functions for the stimuli under consideration (e.g., Anderson &

Bower, 1972; Kintsch, 1970, 1974). Similar recognition and recall functions suggest storage differences, while independence between recognition and recall suggests retrieval differences. In the present context, we can use this comparison to investigate the locus of the levels effect. If subjects encode important propositions more reliably than unimportant ones, the levels effect should obtain for recognition, as well as for recall. On the other hand, the failure to obtain recognition differences would favor a retrieval interpretation. Prior prose studies found no levels effect for immediate recognition (Caccamise and Kintsch, 1978; McKoon, 1977; Miller, Perry & Cunningham, 1977), although the first two of these studies did obtain an effect on a delayed recognition test. None of this work, however, has systematically tested the relation between recognition and recall or selected test items from several levels in a structural representation of moderate-length texts.

Memory Structure. Researchers in human narrative memory commonly assume hierarchical representations of stories in memory (Kintsch & van Dijk, 1978; Mandler & Johnson, 1977; Rumelhart, 1975; Stein & Glenn, 1979; Thorndyke, 1977). These models propose that a hierarchy comprises nested clusters of conceptually related propositions. Generally, relatedness is defined by membership in a story constituent. For example, two story events from the same EPISODE (Rumelhart, 1975; Thorndyke, 1977) are more closely related (i.e., are separated by fewer relational links) in the memory representation than two events in successive EPISODES. Since the strength of association between two propositions varies inversely with the number of links between them, within-cluster associations should be stronger than between-cluster associations. This prediction can be tested by measuring the transitional recall

probabilities of adjacent propositions in the input text. Since associative strength within clusters is presumably greater than between clusters, the conditional recall of a proposition (i+1) given recall of its predecessor (i) (written as P (i+1/i)) should be greater when the two propositions occur in the same narrative constituent than when they occur in different constituents (Thorndyke, 1978).

The assumption that story memory is organized hierarchically may be contrasted with the assumption that memory is heterarchical. Memory models that assume heterarchical organization essentially deny that propositional information from stories is organized into clusters according to abstract constituents of story structure. Rather, propositions are linked only via associations among repeated concepts, independent of their role in the narrative. This assumption implies that the conditional probability of recalling any proposition given recall of its immediate neighbor should, in general, be independent of the roles of the two propositions in the story. So, for instance, the conditional probability of recalling adjacent propositions within a particular EPISODE (as defined by a hierarchical model) should be the same as recalling adjacent propositions from different episodes.

Search Process. When people are asked to recall a previously learned story, they must gain access to and search their memory representation of the story. Three possible strategies that could operate on memory are direct-access, top-down search, or sequential search. Direct-access memory retrieval is generally thought of as a stochastic process in which the representational structure in memory may be entered at any location (e.g., Anderson & Bower, 1973). While it is typically assumed that presentation of an item for recognition enables

direct access to memory, we may extend the notion of direct access to the recall process as well. Thus, recall of a proposition may be independent of the other contents of memory. As a consequence, each stored proposition has an equal chance of being accessed for either recognition or recall. This search process might operate on either a heterarchical or hierarchical memory organization.

Alternatively, one might assume that search through the story propositions depends on serial associations between juxtaposed propositions. Such associations would presumably be formed according to argument or concept repetition in the text (Anderson, 1980; Kintsch, 1974), or on the explicit encoding of causal and temporary dependencies (Norman & Rumelhart, 1975). While such associations would be most easily accommodated in a heterarchical representation, one might assume that such associations are formed in addition to a hierarchical representation based on story structure.

In contrast, a top-down search mechanism can only function on hierarchical structures, since top-down search implies a traversal through distinct levels of the memory representation. Such a search process implies certain dependencies among propositions represented at different levels in the hierarchy. Retrieval of a subordinate proposition would, in general, depend on retrieval of its superordinate parent. Furthermore, assuming a probabilistic strength parameter associated with relational links in memory, the recall probability of a subordinate proposition would be smaller than the recall probability for its parent. When searching a hierarchical structure, one must access and retrieve a superordinate proposition (i), before searching the next lower level for an immediate subordinate (i+1). When i+1 is recalled, i should also

have been retrieved. Thus the conditional recall probability of retrieving i+1 given recall of i (P(i+1/i)) should exceed the conditional probability of recalling i+1 when i is not recalled (P(i+1/$\bar{i}$)) if the search is top-down. Similarly, if search proceeds sequentially through the text propositions, the probability of recalling a proposition should be higher if its predecessor is recalled than if it is not. Conversely, a direct-access search process allows for independent and equiprobable retrieval of i and i+1. As a consequence, this search assumption would predict no difference between P(i+1/i) and P(i+1/$\bar{i}$).

Memory Contents. Two distinct views have emerged regarding the representation of linguistic information in memory. The most widely accepted view, the conceptual one, argues that propositional information is represented in memory in abstract, conceptual form (e.g., Bransford & Franks, 1971; Kintsch, 1974; Rumelhart, Lindsay & Norman, 1972; Schank, 1976). According to this view, people remember the gist of a text and forget exact wording because the representation in memory is primarily semantic. Memory thus reduces discriminability among pieces of information that are conceptually similar, but lexically different. Thus, in only a short time after a text's presentation, people verify explicit and implicit text propositions equally quickly (Kintsch, 1974) and cannot distinguish among different lexical versions of the material (Bransford & Franks, 1971).

The lexical view, on the other hand, argues that memory representations maintain lexical and syntactic integrity in memory. That is, two or more synonymous propositions may be represented and integrated in an associative memory structure that preserves the lexical elements and identity of each (Hayes-Roth & Hayes-Roth, 1977; Hayes-Roth & Thorndyke,

1979; Walker & Meyer, 1980). Thus, people can often discriminate between previously learned sentences and meaning-preserving distractors with changed lexicon and syntax (Caccamise & Kintsch, 1978; Hillinger, 1977; Hayes-Roth & Thorndyke, 1979). Further, the comprehension and verification of synonymous sentences requires more time than when the wording of the sentences is identical (Hayes-Roth & Hayes-Roth, 1977; Yekovich & Walker, 1978).

These two views clearly differ with respect to predictions about the correct verification of (a) original sentences from a text (OLDs) and (b) lexical and syntactic transformations of original sentences (PARAPHRASEs). With both immediate and delayed testing, the conceptual models would predict that people should be unable to discriminate OLD from PARAPHRASE test sentences. A lexical model, on the other hand, would predict that subjects can discriminate between OLD and PARAPHRASE statements on both immediate and delayed testing.

The Composite Models

In the previous section we outlined four classes of structure and process assumptions and predictions following from specific assumptions. In the following paragraphs we combine these assumptions into different process models of memory. Subsequently, we present a memory experiment that tests the predictions of these models.

Table 1 summarizes the models we derived. The left panel of the table displays three model attributes that have been combined to form ten models, labeled 1L-10L. The postscript L indicates that the models incorporate the assumption of lexical memory contents. Ten additional models, not shown in Table 1, can be derived by substituting the

postcript C, indicating conceptually-based memory representation. The right panel of the table summarizes the predictions associated with models. The predictions refer to the outcomes of data analyses to be performed in the reported experiment. The experiment required subjects to read short multi-episode narratives and perform either immediate or one-hour delayed tests of recall and recognition. Analyses of the structure of the stories according to Thorndyke's (1977) story grammar provided a priori measures of propositional importance. Subjects' recall data were scored for (a) the proportion of propositions remembered as a function of propositional importance, (b) the transition probability for recall of adjacent propositions from the input sequence, and (c) the conditional recall of subordinate propositions given recall or non-recall of their superordinates (indicated in the last column of Table 1). Recognition data were scored for the proportion of correctly identified OLDs, PARAPHRASEs, and FALSEs, as a function of propositional importance. The following discussion briefly describes each model in Table 1.

Model 1L. This model, like models 2L-5L, assumes that the use of narrative schemata during comprehension leads to differential probabilities of encoding text propositions. The resulting memory representation is hierarchical, and search entails direct access to stored propositions. This model, like models 2L-5L, predicts a levels effect for both recall and recognition due to differential initial encoding of propositions. In addition, the direct access search assumption of model 1L predicts no dependencies between recall of successive propositions.

Table 1

A SUMMARY OF THE MODELS AND THEIR PREDICTIONS

Model Number	Assumption			Prediction			
	Encoding Bias	Memory Structure	Search Process	Recall Levels Effect	Recognition Levels Effect	$P(i+1/i)_{WITHIN} > P(i+1/i)_{BETWEEN}$	$P(i+1/i) > P(i+1/\bar{i})$
1L	Yes	Hierarchical	Direct Access	Yes	Yes	No	No
2L	Yes	Hierarchical	Top-Down	Yes	Yes	Yes	Yes
3L	Yes	Hierarchical	Sequential	Yes	Yes	Yes	Yes
4L	Yes	Heterarchical	Direct Access	Yes	Yes	No	No
5L	Yes	Heterarchical	Sequential	Yes	Yes	No	Yes
6L	No	Hierarchical	Direct Access	No	No	No	No
7L	No	Hierarchical	Top-Down	Yes	No	Yes	Yes
8L	No	Hierarchical	Sequential	No	No	Yes	Yes
9L	No	Heterarchical	Direct Access	No	No	No	No
10L	No	Heterarchical	Sequential	No	No	No	Yes

Model 2L. This model differs from 1L in assuming a top-down search through the hierarchical memory representation to retrieve propositions. As a consequence of this search assumption, the search distance between successive propositions in different major narrative elements--i.e., setting, theme, plot, resolution--is in general greater than the distance between successive propositions within a constituent. Similarly, the distance between two propositions in different episodes is greater than the distance within an episode. Thus, the within-episode transition probability should exceed the between-episode transition probability. This model also predicts that recall of a subordinate proposition depends in large part on successful retrieval of its immediate superordinate. Thus, as the last column of Table 1 indicates, recall of a proposition should be better when its parent is recalled than when its parent is not recalled.

Model 3L. Model 3L differs from model 1L in assuming a sequential search of propositions, unmediated by the organizational hierarchy. Since within-constituent pairs of propositions are presumably more closely related than between-constituent propositions, within-constituent transition recall probabilities should exceed between-constituent transition probabilities. Thus, the predictions of this model cannot be distinguished from those of model 2L.

Model 4L. This model presumes a heterarchical memory representation and direct access memory search. Since this model makes no distinctions among narrative categories, it predicts no differences in transition probabilities. The direct-access assumption predicts independence between recall of a proposition and its parent (as designated by the hierarchical representation).

Model 5L. This model assumes a heterarchical representation and sequential search. The predictions of this model differ from those of 4L only in the presumption that recall of a proposition should be higher when its predecessor is recalled than when it is not.

Model 6L. Models 6L-10L assume that narrative schemata guide the comprehension but not the encoding probabilities of incoming story information. Model 6L assumes direct access retrieval of propositions from a hierarchical memory representation. Since all propositions are, in general, stored and retrieved with equal probability, this model predicts no differences on any of the comparisons in Table 1.

Model 7L. Model 7L differs from 6L in assuming top-down search. This model thus predicts a levels effect in recall based on probabilistic retrieval. Further, within-constituent transition probabilities should exceed between-constituent probabilities, and subordinate proposition recall should depend on recall of its parent, as argued for the other model that assumes hierarchical organization and top-down search (see Model 2L).

Model 8L. This model differs from 6L in assuming sequential search. Since the hierarchy is not used for retrieval, recall should not vary as a function of hierarchical level. However, as predicted for the other hierarchical, sequential search model (3L), within- and between-constituent transition probabilities should differ, as should recall of subordinates given either recall or non-recall of parent propositions.

Model 9L. This model assumes heterarchical representations and direct-access search. The predictions of this model are identical to those for the model presuming direct-access search on a hierarchical

representation (Model 6L).

Model 10L. This model differs from 9L in assuming sequential search. Its predictions differ from those of 9L only in assuming that recall of a proposition depends on the success of the attempt to recall its predecessor.

Models 1C-10C. Models 1C-6C are identical to 1L-10L, respectively, with the exception of the memory contents assumption. The conceptual models propose that the surface features of text are discarded and that only the conceptual content, or meaning, of the passages are encoded. Thus, on a recognition test, subjects should not be able to verify the exact syntactic form of the original material. Models 1L-10L, on the other hand, assume that people retain lexical features of text, thereby allowing accurate verification of syntax on both immediate and short-delay tests.

METHOD

Materials

We created four texts differing in topic and semantic content for use as experimental materials. President Andrew Johnson described events surrounding Johnson's unsuccessful term in office. The Communist Party in Spain recounted a historical sequence of the Communist party's attempts to gain official party recognition in Spain. The Chemical Plant was a fictitious story about a citizen's group concerned with the physical welfare of the employees in a fertilizer manufacturing plant. Finally, The Assassin concerned a fictitious German civil servant who investigated the alleged assassination of Adolph Hitler. For purposes

of illustration, the text of the Andrew Johnson story appears in the Appendix.

The stories followed the stereotypical structural conventions of simple narratives (see Thorndyke, 1977; Thorndyke & Yekovich, 1980). Each contained a plot structure in which a protagonist faced some conflict and eventually resolved it through a series of episodes, each representing an attempt to achieve some subgoal. We used Thorndyke's (1977) grammar to represent the underlying structure of these stories, each of which contained a hierarchy of center-embedded episodes. The four stories ranged in length from 223 to 331 words, from 36 to 51 propositions, and from 5 to 16 levels in their hierarchical representations.

Recognition test items were constructed from story propositions for each of the passages. Three types of items were included. OLD statements were single propositions taken verbatim from the original story. PARAPHRASE statements comprised OLD propositions with changed syntax and with the original content words replaced by synonymous terms. FALSE items were OLD statements with incorrect details substituted for original information. Typically, this substitution involved names, places, and dates. The following examples from the Andrew Johnson story illustrate each item type:

OLD	(1)	The impeachment attempt failed.
	(2)	The Radicals had succeeded in gaining control of the government.
PARAPHRASE	(1')	The plan to impeach Johnson was unsuccessful.
FALSE	(2')	The Democrats had succeeded in gaining control of the government.

Because the stories contained different numbers of propositions, the recognition tests also varied in length. The Andrew Johnson, Communist Party, Chemical Plant, and Assassin tests contained 38, 40, 48, and 66 items, respectively. Half of the items on each test were OLD statements. The remainder included equal numbers of PARAPHRASE and FALSE items. All hierarchical levels were represented by items of each type.

Subjects

Twenty-one high school and college volunteers were paid $7.00 for their participation in the two and one-half hour experiment. Five of these subjects were dropped from the study because they failed to complete the entire experiment.

Design

A completely within-subjects design was used. The independent variables were retention interval (zero or sixty minutes), hierarchical level of the passages' propositions, and type of test item (recall or the three recognition test item types). The dependent variable was the percentage of correct responses on each test. The assignment of passage to retention condition was counterbalanced across subjects.

Procedure

Subjects were tested in groups of from one to five people. They were given booklets containing instructions, stories (printed one per page), and associated test materials. The initial instructions informed subjects that they would receive two tests on each story--one test requiring writing as much as they could remember from the story, the

other requiring the identification of statements from the story. Subjects were instructed to read each story once at a normal reading rate and to not turn back to previous pages.

Subjects' work through the booklets was self-paced. Half of the subjects read two stories with a free recall and a recognition test immediately after each. They then read two more stories, followed by a one-hour interpolated map-learning exercise. After this interval, they completed the recall and recognition tests for each of the final two stories. The other half of the subjects first read two stories, performed the map-learning test, and then completed the recall and recognition test. Subsequently, these subjects read and were tested immediately on the two remaining stories.

The instructions for the recall test directed subjects to write everything they could remember from the passages. Verbatim recall was encouraged, but they were told that paraphrases and incomplete sentences were allowed. Story titles were provided as recall prompts, and recall time was unlimited. The instructions for the recognition test advised students to decide whether or not each test sentence was an exact statement from the passage. The instructions informed subjects that some distractor items were paraphrases of story sentences and that others contained incorrect details. These items were to be judged FALSE. For each item, subjects first judged the statement's truth value and then indicated their response confidence using a one (guess) to five (completely confident) scale. Presentation of test items was randomized for each subject and each test. Again, there was no limit on completion time.

RESULTS

Recall

Subject recall protocols were scored for propositional content Recalled propositions were counted as correct when they captured the gist of an original story proposition. Because of the small number of propositions at each hierarchical level, we combined some hierarchical levels and collapsed the data across stories for subsequent data analyses. This resulted in acceptable numbers of propositions contributing to each data point (between 27 and 52).

Figure 1 depicts the mean proportions of propositions recalled as a function of location in the story structure. Using the arcsin transformations of proportional recall, a repeated measures analysis of variance was performed with test condition (immediate, delay) and propositional level (1, 2, 3-4, >5) as main factors. As expected, subjects recalled more on the immediate than on the delayed test, F (1,15) = 9.04, p < .001, MSe = .133. Hierarchical level also produced a significant main effect, F (3,45) = 16.94, p < .001, MSe = .114. There was no interaction between test condition and hierarchical level (p > .25). Newman-Keuls tests declared that level 1 propositions were recalled better than propositions from all other levels (p < .01), and that the lowest level propositions were recalled worse than all others (p < .05). This result confirms the finding of other prose studies demonstrating better recall for high-level information than for low-level information (Meyer, 1975; Thorndyke, 1977).

Using a different analytic method, Black and Bower (1980) failed to find a levels effect in recall of narratives. To compare our results to

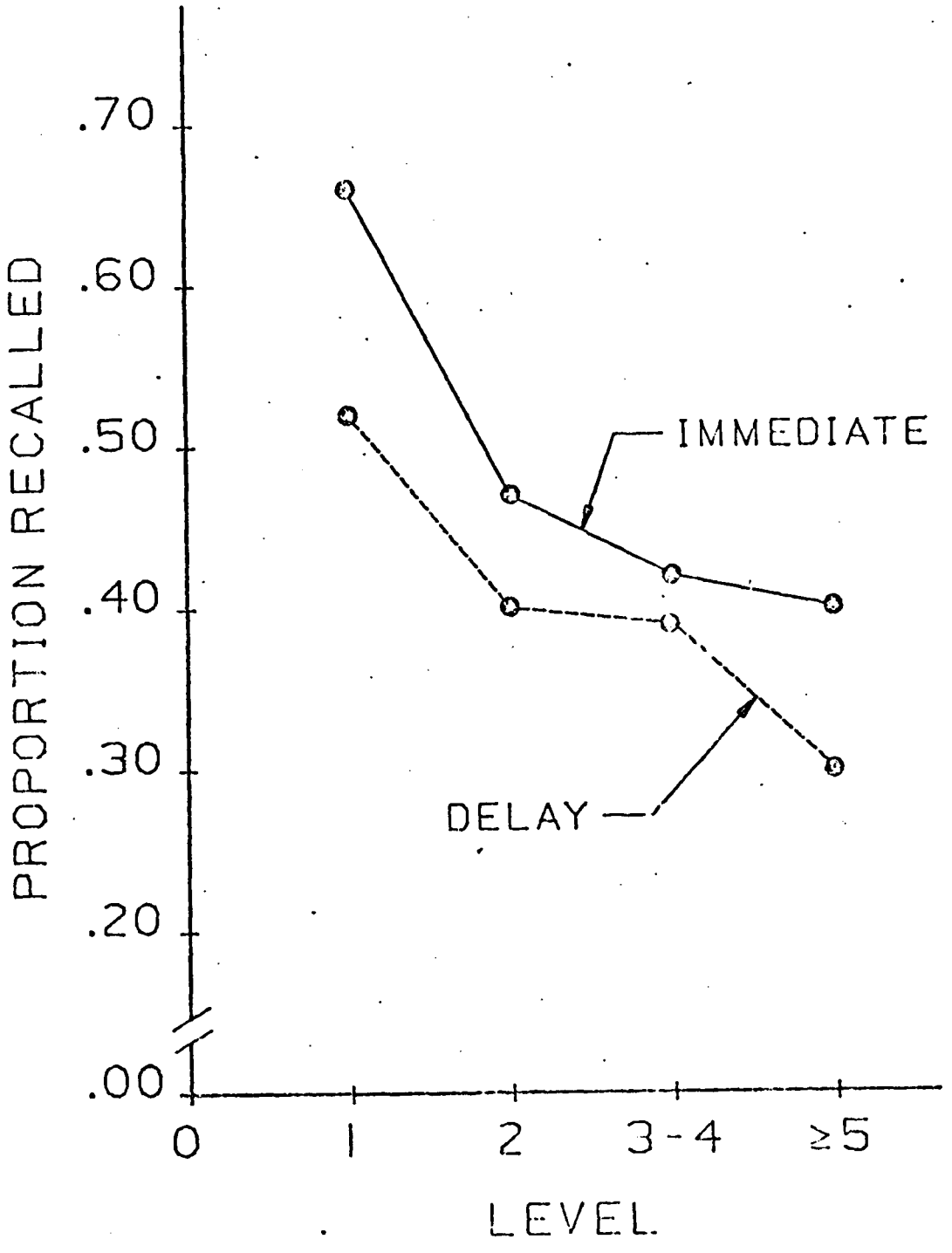

Figure 1. Recall proportions for story propositions as a function of location in the organizational hierarchy.

theirs, we also analyzed the recall results using their method. We rank ordered the propositions for each story according to the percentage of subjects who recalled each proposition. We than correlated these ranks with the hierarchical level of the propositions. For the Communist Party ($\underline{r}$ = .33) and Assassin ($\underline{r}$ = .24) stories, these correlations were reliable ($\underline{p} < .05$). The correlations for the Andrew Johnson ($\underline{r}$ =.27, $p < .07$) and Chemical Plant ($\underline{r}$ = .21, $p < .11$) stories were in the same range but failed to achieve significance.

Simple recall probabilities alone provide little direct evidence for any of the proposed memory models. As Table 1 shows, six of the ten models predict the obtained result. To distinguish between the heterarchical and hierarchical models, we computed conditional recall probabilities for each pair of adjacent propositions in the stories. This transition probability provides a measure of associative strength between propositions. The hierarchical models presume that propositions are stored in memory in clusters dictated by the story structure. Consequently, the associative strength or "transition probability" of adjacent propositions within a cluster (i.e., $P(i+1/i)_{WITHIN}$) should exceed that of adjacent propositions belonging to different clusters ($P(i+1/i_{BETWEEN}$). In contrast, the heterarchical models assume no such clustering. To test this hypothesis, we computed two pairs of transition probabilities for each subject. The first test considered a cluster to be one of the four top-level constituent categories in the story: SETTING, THEME, PLOT, or RESOLUTION (see Thorndyke, 1977). The first line of Table 2 summarizes the mean probabilities. A matched pairs t-test (two-tailed) on these data showed that the transition probability within clusters did not differ from the between category probability,

$t(15) = -1.66$, $p > .05$. However, an inspection of the items comprising this comparison suggested that these transition probabilities may have been biased in favor of the between-cluster transition probability. For each of the between-cluster computations, the proposition falling in the second cluster occurred at either level 1 or level 2 in the representational hierarchy. Thus, the high a priori free recall probability of these propositions compared to the corresponding propositions in the within-cluster set may have inflated the value of $P(i+1/i)_{BETWEEN}$. Consequently, we computed a second set of transition probabilities using the EPISODE as the basis for defining clusters. Initial propositions in EPISODES occurred at all levels of the story hierarchy (except level 1), thus removing the potential artifact from the estimate of the transition probabilities between clusters. The resulting mean transition probabilities within an EPISODE and between two EPISODEs are provided in the second row of Table 2. In this case, there was a significant recall advantage for propositions within an EPISODE, t (15) = 3.88, $p < .005$. Thus, when this more accurate measure was used, our data supported a hierarchical rather than a heterarchical structural model.

We computed an additional set of conditional recall probabilities to test the top-down, sequential, and direct access search assumptions of the various models. The top-down and sequential search assumptions assume that the recall probability of a subordinate proposition (i+1) will be dependent on recall of its immediate superordinate (i) (see Bower, Clark, Lesgold & Winzenz, 1969, for a discussion of top-down retrieval). In other words, recall of proposition i+1 should be high when i is recalled, and low when i is not recalled. On the other hand, if subjects gain direct access to all propositions in memory, P(i+1/i)

Table 2

MEAN CONDITIONAL RECALL PROBABILITIES WITHIN AND BETWEEN NARRATIVE CONSTITUENTS

Category Type	Conditional Probability	
	$P(i+1/i)$ WITHIN	$P(i+1/\bar{i})$ BETWEEN
Top-level Constituents	.55	.62
Episodes	.60	.40

and $p(i+1/\bar{i})$ should not differ since recall of propositions is independent of recall of their immediate parents. Because we defined a proposition to be a clause containing a verb, it would not be unreasonable, a priori, for a subject to recall a child proposition without recalling its parent. We computed these two probabilities for each subject, collapsing across the four stories. Across, subjects' resulting means were $P(i+1/i) = .63$ and $p(i+1/\bar{i}) = .24$. This difference was highly reliable, $t\ (15) = 9.60$, $p < .001$. These results disconfirm the predictions of models assuming direct access to stored propositions (models 1, 4, 6, and 9).

Recognition

The recognition tests were scored for proportions of correct responses to each of the three item types. This meant that subjects responded true to OLD items, and false to both PARAPHRASE and FALSE items (hereafter called correct rejections). A subject's mean confidence rating for each item type was computed by subtracting incorrect response confidence ratings from correct ones (Corrects-Wrongs) and dividing by the number of items.

Separate analyses of variance were computed for recognition and confidence data and for each item type. Each analysis treated retention interval and hierarchical level as fixed factors. In contrast to the analyses of recall data, the recognition analyses considered only three hierarchical levels (1, 2, ≥3). Collapsing the lower hierarchical levels was necessary because many of the lowest-level propositions had to be combined with their superordinates to create complete sentences for the recognition tests. This reduced the number of remaining low-level

items to the point that their mean estimates were unstable. Analyses of recognition data used arcsin transformations of subjects' recognition probabilities. In all of the analyses, performance was slightly better on the immediate than on the delayed test. However, we obtained no reliable differences ($p < .05$) due either to retention interval or to the interaction between retention interval and hierarchical level. Therefore, we pooled the data across the two retention intervals for presentation of the recognition data (in Figure 2) and the confidence judgments (in Table 3).

The mean correct recognition of OLDs is depicted by the circles in Figure 2. Hit rate was substantially better than chance but did not vary as a function of hierarchical level ($F < 1$). Confidence judgments for these items are shown in the top row of Table 3. As with the recognition data, there were no relable differences due to hierarchical level, F (2, 30) = 2.03, $p > .10$, $MSe = .658$. These data are consistent with the models that presume no systematic differences in the encoding of story propositions (see models 6L-10L in Table 1).

As shown in Figure 2, the proportion of correct rejections of PARAPHRASE items increased with decreasing level in the organizational hierarchy, F (2, 30) = 6.74, $p < .01$, $MSe = .027$. Newman-Keuls tests declared that the lowest-level propositions were rejected correctly more often than Level 1 propositions ($p < .01$). The differences between adjacent points (> = 3 versus 2 and 2 versus 1) were smaller but approached significance ($p = .06$). This ordering of conditions held for both immediate and delayed testing. Further, this pattern was also reflected in subjects' confidence judgments, as shown in the second row of Table 3 (F (2, 30) = 3.21, $p = .055$, $MSe = .947$).

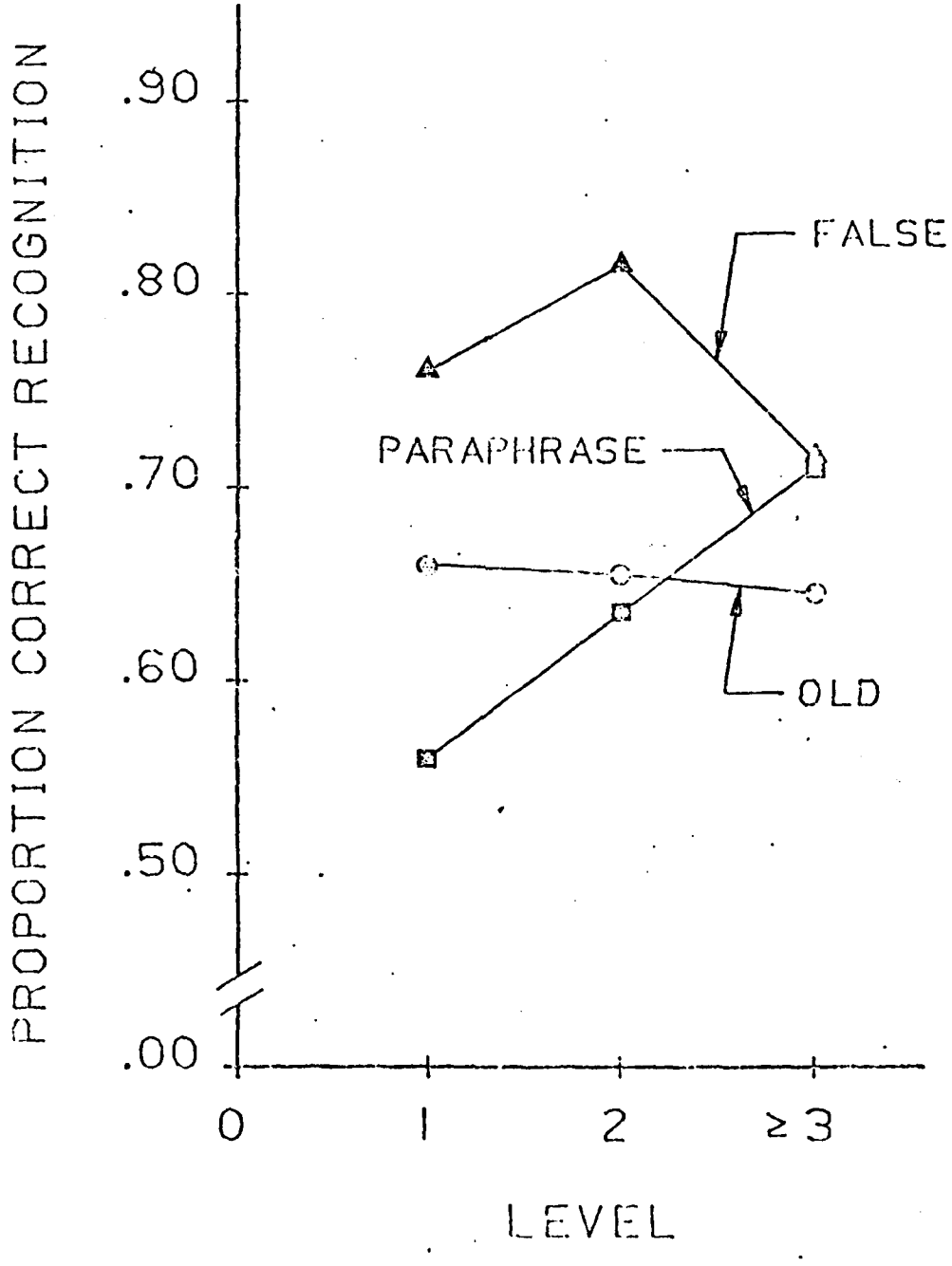

Figure 2. Proportion of correct responses to the different item types on the recognition test as a function of location in the organizational hierarchy.

Table 3

MEAN CORRECTED CONFIDENCE RATINGS FOR OLD, PARAPHRASE, AND FALSE RECOGNITION ITEMS

	Corrected Confidence Rating			
	Level			
Item Type	1	2	3	Mean
OLD	1.39	1.07	1.01	1.16
PARAPHRASE	1.05	1.28	1.64	1.33
FALSE	2.41	2.77	2.16	2.45

Across all levels, subjects identified PARAPHRASEs as new items as often as they identified OLDs as old items. Thus, subjects were much more likely to respond "old" to an OLD than to a PARAPHRASE item, F (1, 15) = 49.90, $p < .001$, MSe = .437. This difference held for both immediate and delayed tests. Similarly, subjects judged OLDs to be old more confidently than PARAPHRASEs, F (1, 15) = 14.01, $p < .002$, MSe = .577. These results provide evidence for the presence and persistence of lexical information in memory.

The top line in Figure 2 displays subjects' performance on FALSE recognition items. The analysis of these data revealed no reliable differences due to hierarchical level. In addition, when these items were used as a correction for guessing on subjects' responses to OLD items, the resulting correct recognition probability did not differ across hierarchical level. These results further support the conclusion that subjects encoded both high- and low-level story information.

Recall-Recognition Correlations

To obtain a more direct comparison of recall and recognition of propositions, we computed for each OLD proposition the proportion of subjects who recalled it correctly and the proportion of subjects who recognized it correctly. These proportions were transformed to arcsin values and correlations between these scores were computed across propositions. Table 4 displays these correlations across all propositions and for propositions at different hierarchical levels. Table 4 clearly demonstrates the independence between propositional recall and recognition--no correlation approached significance.

Table 4

CORRELATIONS BETWEEN RECALL AND RECOGNITION
OF STORY PROPOSITIONS

	Level			
	1	2	≥ 3	Total
Correlation (r)	.025	-.095	.098	.039
Number of Observations	(20)	(29)	(44)	(93)

DISCUSSION

This experiment was designed to test several plausible accounts of how narrative schemata influence memory for information in simple stories. These accounts differed according to assumptions about (1) encoding biases, (2) memory structure, (3) search processes, and (4) memory contents. We may now evaluate the twenty models proposed in the introduction in light of the experimental results just presented.

The first major attribute distinguishing the models was whether or not schemata bias the encoding of the story propositions. Models that presume an encoding bias (i.e., Models 1-5 in Table 1) would predict that high-level, important story propositions should be attended to and encoded with higher probability than low-level, less important details. These models, then, predicted a levels effect for both recall and recognition. Models that assume no encoding bias (i.e., Models 6-10) predict no recognition differences. Our data, like those of other researchers, showed the usual levels effect in recall of propositional information (Graesser, 1978; Kintsch, 1974; Meyer, 1977; Rumelhart, 1977; Thorndyke, 1977; Waters, 1978). However, the recognition data contained no evidence for an effect of propositional importance, either on the immediate or on the delayed test. Similar results have been reported by other researchers (e.g., Caccamise & Kintsch, 1978; McKoon, 1977; Miller, Perry, & Cunningham, 1977; Walker & Meyer, 1980), although the first two of these studies did find superior recognition of high-level information on a delayed test. These results combined with the low correlation between propositional recall and recognition indicate that subjects were able to recognize low-level information that they could not recall.

Thus, the levels effect in recall cannot be attributed to an encoding bias for propositional information. Rather, it appears that these differences are due to differential retrievability of the information at recall time, as proposed by Model 7 in Table 1.

This retrieval explanation for the levels effect in recall has been proposed by several other researchers (Britton, Meyer, Simpson, Holdredge & Curry, 1979; Graesser, 1978; Waters, 1978). Britton et al., based this conclusion on the observation that the probability of recall of a sentence, but not the cognitive capacity nor the time required to read it, increased with increasing importance of the sentence. (However, Cirilo & Foss (1980) have reported that increasing propositional importance increases reading time.) Graesser and Waters both observed that subjects recalled more high-level than low-level information even when subjects had equal familiarity with and knowledge of high- and low-level information in the to-be-recalled material. Thus, the available evidence strongly favors the retrieval explanation over the storage explanation for the levels effect.

The second attribute distinguishing the models in Table 1 is nature of the memory representation of stories. Of the models proposed in Table 1, only the model assuming a hierarchical representation and no encoding bias is consistent with both recall and recognition data. In contrast, models 4, 5, 9, and 10 hypothesize a heterarchical organization. The obtained difference in the transition recall probabilities (P(i+1/i)) within and between episodes is inconsistent with these models. The hierarchical, but not the heterarchical, models assume greater associative strength within narrative clusters than between them.

Several other studies have also suggested the hierarchical, clustered nature of memory representations. Haberlandt (1980) found that reading times for boundary sentences of an episode were longer than for other sentences in the episode. He argued that this difference reflected a greater processing load for boundary information resulting from the formation of high-level memory clusters encoding each episode. Similarly, Black & Bower (1979) argued for episode chunking in memory by showing that alteration of the events in one episode of a two-episode story influenced only recall of the altered episode. Finally, analysis of clusters in story recall by Buschke and Schaier (1979) suggested that the clusters in recall correspond closely to those proposed by Thorndyke's (1977) hierarchical memory model for stories. Thus, these data argue in favor of a memory structure that represents story information in a hierarchical organization.

The third attribute of human story processing we considered was the type of memory search process used for recall of story information. We contrasted a process that allowed essentially direct access to each stored proposition with a process that required search through a stored representation of the learned text. The latter type of process might entail a top-down traversal of a hierarchical structure or a straightforward sequential retrieval of propositions. Our results indicated that the conditional probability of recalling a proposition given recall of its predecessor was much higher than when the predecessor was not recalled. This result is inconsistent with the direct-access assumption, but is consistent with the sequential and top-down assumptions. While we are not able to distinguish between the sequential and top-down search assumptions, only one model we have considered is consistent with

all the obtained data. That model, Model 7 in Table 1, assumes a top-down search through a hierarchical memory representation.

The data from several other studies support this top-down, hierarchical search assumption. A model incorporating a sequential search assumption has difficulty accounting for the superiority in recall of high-level over low-level information (e.g., Britton et al., 1979; Graesser, 1978; Meyer, 1977; Rumelhart, 1977; Thorndyke, 1977; Waters, 1978). Reder and Anderson (1980) argued that details in a hierarchical memory representation of a text can be retrieved only by first retrieving higher-level points, but that the converse does not hold. That is, details do not support memory for the central, important ideas. A non-hierarchical, sequential retrieval model would be unable to account for such an asymmetry in cue effectiveness. Finally, Walker and Meyer (1980) found that subjects verified inferences based on high-level text information better than inferences based on low-level information. At the same time, recognition of the high- and low-level information comprising the premises was equivalent. This result suggests that subjects were more successful at searching for and retrieving high-level information to support inferencing than they were at retrieving equally well encoded low-level information. Again, these data favor the top-down over the sequential search assumption.

To summarize our evaluation of the models in Table 1, models 1, 4, and 9 made three (out of four) inaccurate predictions, models 6 and 10 each made two inaccurate predictions, and models 2, 3, and 8 made one each. Model 7, which assumed no encoding bias, a hierarchical representation, and a top-down search process, was correct in all four predictions. Thus, of the ten models considered, this model offers the most

plausible account of subjects' processing of simple stories.

It is conceivable, of course, that these attributes of memory are not static, but vary to accommodate changes in text characteristics, task constraints, memorial strength, and so on. For example, one might suppose that memory search is more flexible and complex than we have proposed. To illustrate, suppose that the retrieval of information from memory on a recognition test depends on the strength of the memory representation. When the memory representation is strong (e.g., immediately after presentation), subjects can directly access memory at any location. However, when the memory representation is weak (e.g., after a long retention interval), subjects are unable to retrieve propositions directly. Rather, suppose they must search top-down through a hierarchical representation to retrieve the proposition corresponding to the presented recognition item. Such a model would predict equal recognition for high- and low-level information on an immediate test. However, on a delayed test, the top-down search requirement would predict better and faster recognition of high- and low-level information. In fact, there is some evidence for such a composite model. Caccamise and Kintsch (1978) found a levels effect for recognition of story information on a delayed, but not an immediate test. McKoon (1977) found that reaction times to verify high- and low-level story propositions differed on a delayed but not on an immediate test.

Another test of this model involves the recognition dependencies of superordinate and subordinate information on the delayed test. If memory retrieval on the recognition test is via direct access on the immediate test, then the probability of recognition of a proposition should be the same regardless of whether its parent was recognized. On

the delayed test, however, a top-down search assumption implies that recognition of a proposition should be higher when its parent is also recognized than when it is not. Table 5 summarizes these conditional probabilities. On the immediate test, there was essentially no difference between these conditional probabilities ($P(i+1/i)$ was larger than $p(i+1/\bar{i})$ for 8 of 16 subjects). However, recognition on the delayed test was much more likely when the immediate parent was recognized than when it was not. This result was obtained for 14 of the 16 subjects ($p < .01$). These results, although based on post hoc analysis, suggest possible areas for elaboration and extension of the models we have tested here.

The last attribute we considered was the nature of the contents of memory. In particular, we were interested in whether or not subjects retain surface information from the presented stories in their memory representations. We found that in both immediate and delayed tests, subjects could discriminate between OLD and PARAPHRASE statements from the stories. Further, discriminability varied inversely as a function of the importance of the propositions. Identification of PARAPHRASEs was more accurate for low-level than for high-level propositions. Hence, these results support earlier findings that subjects retain surface information in their memory representation of stories (Hayes-Roth & Thorndyke, 1979; McKoon, 1977).

The pattern of performance on PARAPHRASE statements is noteworthy. Exactly why people can identify low-level PARAPHRASEs more readily than high-level PARAPHRASEs poses an intriguing question. One possible explanation for this result presumes systematic differences in the semantic content of information at various levels in the narrative

Table 5

CONDITIONAL PROBABILITIES FOR RECOGNITION OF PROPOSITIONS GIVEN RECOGNITION OR NON-RECOGNITION OF IMMEDIATE PARENT

Test Condition	Conditional Probability	
	$P(i+1/i)$	$P(i+1/\bar{i})$
Immediate	0.58	0.54
Delay	0.75	0.48
Mean	0.69	0.50

hierarchy. Conceivably, important information may be richer semantically or less constrained in exact content than low-level information. As a consequence, high-level information may permit more alternative surface realizations than low-level information. On a recognition test, then, this flexibility could lead to higher false alarm rates for important statements (see Nezworski, Stein & Trabasso, Note 1; Thorndyke & Yekovich, 1980). An alternative explanation assumes that subjects allocate equal processing effort to high- and low-level information (Britton et al., 1979). If high-level information requires more structural integration because of its central role in the narrative organization, fewer resources would be available to consolidate the memory representation of precise content. Thus, the content of low-level propositions would be more strongly represented than for high-level propositions. In support of this hypothesis, Thorndyke (1977) found that surface memory for propositions in a text improved as the amount of coherence and structure in the text decreased. In any case, regardless of the cause of this effect, it is clear that people retain much of the surface information from all levels of importance in the stories they read.

Several researchers have recently pointed out the vagueness with which the notion of story schemata has been applied in modeling human memory (Cirilo & Foss, 1980; Thorndyke & Yekovich, 1980). This study set out to clarify several of the outstanding issues and to evaluate a variety of plausible, explicit models against previous and new data. While we have not directly addressed the use of narrative schemata to guide comprehension, it appears that the products of this process include a hierarchical, structured representation of both high- and low-level surface information from the stories. When the reader must

retrieve information from memory, (s)he consults the stored representation, using a narrative structure as a retrieval plan (e.g., Mandler, 1978; Thorndyke, 1977). Using a top-down, breadth-first search through this hierarchical structure, subjects can both retrieve story information in the correct order and use structural information from the schema to generate plausible guesses when retrieval fails (Thorndyke, 1978). This model places some constraints on the possible roles of memory schemata in guiding comprehension, encoding, and retrieval. However, it is only a first step on the road to a comprehensive account of people's processing of narrative texts.

APPENDIX

President Andrew Johnson

When Abraham Lincoln was assassinated in 1865, the new President was Andrew Johnson. After the Civil War, Johnson needed to devise a reconstruction program to achieve social and racial equality in the South. Johnson was a Democrat from Tennessee, and thus he favored a moderate and lenient program. Radical Republicans in Congress, however, favored harsh policies and proposed more extreme reforms in the South. Radical programs for reconstruction passed by Congress were regularly vetoed by President Johnson. The Radical Republicans were determined to consolidate their political strength. As a result, they wanted to remove Johnson from office as soon as possible and replace him with a political ally. They decided to impeach him for violating the laws enacted by Congress. After overwhelmingly voting for impeachment in the House, the Radicals needed a two-thirds vote in the Senate. The Radicals used a variety of pressures to force individual Senators into voting guilty. However, the final vote fell one short of the number required for impeachment. Thus, the impeachment attempt failed. However, in 1868 the Radical Republicans hoped to remove Johnson by defeating him in the Presidential election. They nominated Ulysses S. Grant, a war hero, as their candidate. The Democrats bypassed Johnson and nominated Horatio Seymour of New York. Grant won the election by only 300,000 votes. However, the Radicals had succeeded in gaining control of the government.

REFERENCES

Anderson, J. Concepts, propositions, and schemata: What are the cognitive units? Technical Report 80-2, Department of Psychology, Carnegie-Mellon University, 1980.

Anderson, J., & Bower, G. Recognition and retrieval processes in free recall. Psychological Review, 1972, 79, 97-123.

Anderson, J., & Bower, G. Human associative memory. Washington, D.C.: V. H. Winston & Sons, 1973.

Anderson, J., & Bower, G. A propositional theory of recognition memory. Memory and Cognition, 1974, 2, 406-412.

Anderson, J., & Reder, L. An elaborative processing explanation of depth of processing. In L. Cermak & F. Craik (Eds.), Levels of processing in human memory. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1979.

Bartlett, F. Remembering. Cambridge: Cambridge Press, 1932.

Black, J., & Bower, G. Episodes as narrative chunks in memory. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 309-318.

Black, J., & Bower, G. Story understanding as problem-solving. Poetics, 1980, 9, 223-250.

Bower, G., Clark, M., Lesgold, A., & Winzenz, D. Hierarchical retrieval schemes in recall of categorized word lists. Journal of Verbal Learning and Verbal Behavior, 1969, 8, 323-343.

Bransford, J., & Franks, J. The abstraction of linguistic ideas. Cognitive Psychology, 1971, 2, 231-350.

Britton, B., Meyer, B., Simpson, R., Holdredge, T., & Curry, C. Effects of the organization of text on memory: Tests of two implications of a selective attention hypothesis. Journal of Experimental Psychology: Human Learning and Memory, 1979, 5, 496-506.

Buschke, H., & Schaier, A. Memory units, ideas, and propositions in semantic remembering. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 549-563.

Caccamise, D., & Kintsch, W. Recognition of important and unimportant statements from stories. American Journal of Psychology, 1978, 91, 651-667.

Chiesi, H., Spilich, G., & Voss, J. Acquisition of domain-related information in relation to high and low domain knowledge. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 257-274.

Cirilo, R., & Foss, D. Text structure and reading time for sentences. Journal of Verbal Learning and Verbal Behavior, 1980, 19, 96-109.

Collins, A., & Loftus, E. A spreading-activation theory of semantic processing. Psychological Review, 1975, 82, 407-428.

Frederiksen, C. Representing logical and semantic structure of knowledge acquired from discourse. Cognitive Psychology, 1975, 7, 371-458.

Graesser, A. How to catch a fish: The memory and representation of common procedures. Discourse Processes, 1978, 1, 72-89.

Haberlandt, K. Story grammar and reading time of story constituents. Poetics, 1980, 9, 99-116.

Hayes-Roth, B., & Hayes-Roth, F. The prominence of lexical information in memory representations of meaning. Journal of Verbal Learning and Verbal Behavior, 1977, 16, 119-136.

Hayes-Roth, B., & Thorndyke, P. Integration of knowledge from text. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 91-108.

James, C., & Hillinger, M. The role of confusion in the semantic integration paradigm. Journal of Verbal Learning and Verbal Behavior, 1977, 16, 711-721.

James, C., Hillinger, M., & Murphy, B. The effects of complexity on confidence ratings in linguistic integration. Memory and Cognition, 1977, 5, 355-361.

Johnson, N., & Mandler, J. A tale of two structures: Underlying and surface forms in stories. Poetics, 1980, 9 51-86.

Kintsch, W. Learning, memory, and conceptual processes. New York: John Wiley & Sons, Inc., 1970.

Kintsch, W. The representation of meaning in memory. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1974.

Kintsch, W. On comprehending stories. In M. Just and P. Carpenter (Eds.), Cognitive processes in comprehension. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Kintsch, W., & van Dijk, T. Recalling and summarizing stories. Langvages, 1975, 40, 98-116.

Kintsch, W., & van Dijk, T. Toward a model of text comprehension and production. Psychological Review, 1978, 85, 363-394.

Kintsch, W., Kozminsky, E., Streby, W., McKoon, G., & Keenan, J. Comprehension and recall of text as a function of content variables. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 196-214.

Mandler, J. A code in the node: The use of a story schema in retrieval. Discourse Processes, 1978, 1, 14-35.

Mandler, J., & Johnson, N. Remembrance of things parsed: Story structure and recall. Cognitive Psychology, 1977, 9, 111-151.

McKoon, G. Organization of information in text memory. Journal of Verbal Learning and Verbal Behavior, 1977, 16, 247-260.

Meyer, B. The organization of prose and its effect on memory. Amsterdam: North Holland Publishing Co., 1975.

Meyer, B. The structure of prose: Effects on learning and memory and implications for educational practice. In R. Anderson, R. Spiro, & W. Montague (Eds.), Schooling and the acquisition of knowledge. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Meyer, B., Haring, M., Brandt, D., & Walker, C. Comprehension of stories and expository text. Poetics, 1980, 9, 203-211.

Miller, R., Perry, F., & Cunningham, D. Differential forgetting of superordinate and subordinate information acquired from prose material. Journal of Educational Psychology, 1977, 69, 730-735.

Norman, D., & Rumelhart, D. Explorations in cognition. San Francisco: W. H. Freeman & Company, 1975.

Reder, L. The role of elaborations in memory for prose. Cognitive Psychology, 1979, 11, 221-234.

Reder, L., & Anderson, J. A comparison of texts and their summaries: Memorial consequences. Journal of Verbal Learning and Verbal Behavior, 1980, 19, 121-134.

Rumelhart, D. Notes on a schema for stories. In D. Bobrow & A. Collins (Eds.), Representation and understanding. New York: Academic Press, 1975.

Rumelhart, D. Understanding and summarizing brief stories. In D. LaBerge & J. Samuels (Eds.), Basic processes in reading: Perception and comprehension. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Schank, R., & Abelson, R. Scripts, plans, and understanding. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1977.

Spilich, G., Vesonder, G., Chiesi, H., & Voss, J. Test processing of domain-related information for individuals with high and low domain knowledge. Journal of Verbal Learning and Verbal Behavior, 1979, 18, 275-290.

Stein, N., & Nezworski, T. The effects of organization and instructional set on story memory. Discourse Processes, 1978, 1, 177-194.

Thorndyke, P. Cognitive structures in comprehension and memory of narrative discourse. Cognitive Psychology, 1977, 9, 77-110.

Thorndyke, P. Pattern-directed processing knowledge from texts. In D.A. Waterman & F. Hayes-Roth (Eds.), Pattern-directed inference systems. New York: Academic Press, 1978.

Thorndyke, P., & Hayes-Roth, B. The use of schemata in the acquisition and transfer of knowledge. Cognitive Psychology, 1979, 11, 82-106.

Thorndyke, P., & Yekovich, F. A critique of schemata as a theory of human story memory. Poetics, 1980, 9, 23-50.

Walker, C., & Meyer, B. Integrating different types of information in text. Journal of Verbal Learning and Verbal Behavior, 1980, 19, 263-275.

Waters, H. Superordinate-subordinate structure in semantic memory: The roles of comprehension and retrieval processes. Journal of Verbal Learning and Verbal Behavior, 1978, 17, 587-597.

Yekovich, F., & Walker, C. Identifying and using referents in sentence comprehension. Journal of Verbal Learning and Verbal Behavior, 1978, 17, 265-277.

REFERENCE NOTES

1. Nezworski, T., Stein, N., & Trabasso, T. Story Structure Versus Content Effects on Children's Recall of Evaluative Inferences. Paper presented at Psychonomics Society Meeting, San Antonio, Texas, 1978.